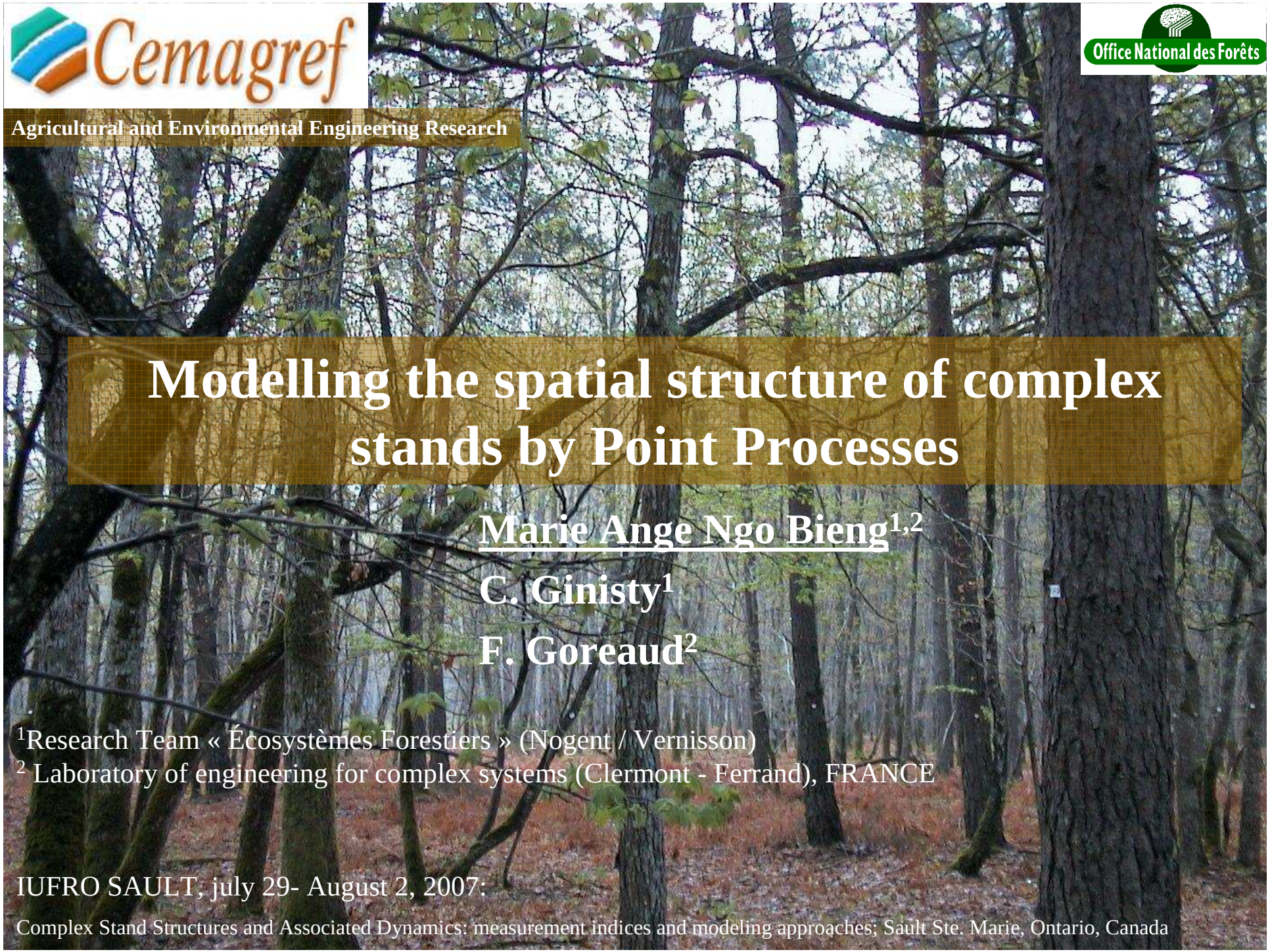

Cemagref

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Modelling the spatial structure of complex stands by Point Processes

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IUFRO SAULT, july 29- August 2, 2007:

Complex Stand Structures and Associated Dynamics: measurement indices and modeling approaches; Sault Ste. Marie, Ontario, Canada

Overview

I. Modelling complex stands structure: Why?

II. Characterising our oak-pine stands spatial structure

III. Modelling: reproducing the identified stands spatial structure

IV. Conclusions and perspectives

I. Modelling Complex stands structure

I. Modelling complex stand structure

- Why?

Complex stand

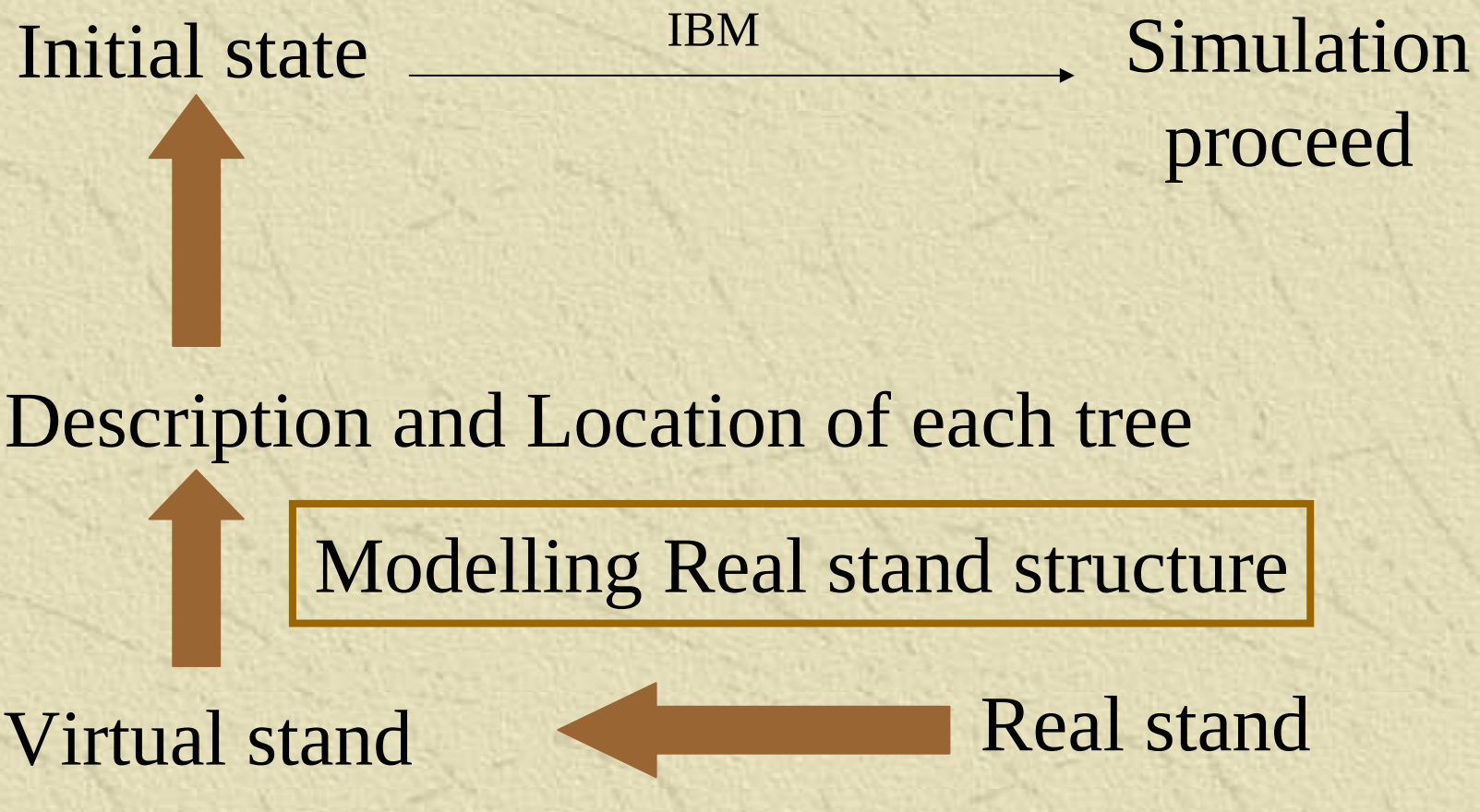
Growth modelling

Individual Based Model (IBM)

spatially explicit

I. Modelling complex stand structure

- Why?



I. Modelling complex stand structure

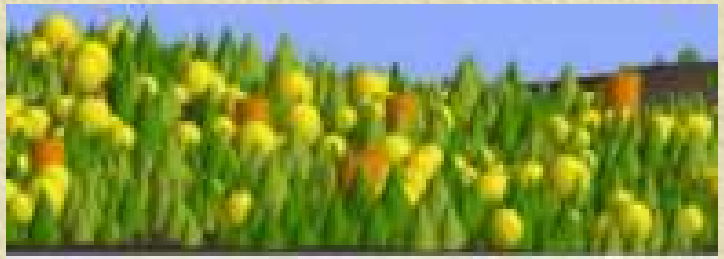
- Our aim: present a model of spatial structure of oak-pine mixed stands.

We are focusing on mixed stands of sessile oak ***(Quercus petraea)*** – Scots-pine ***(Pinus sylvestris)*** of the Orleans forest (France).

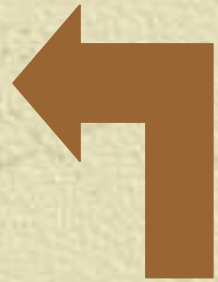
I. Modelling complex stand structure

- Our aim: modelling the spatial structure

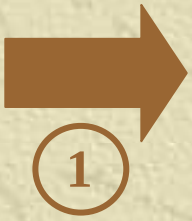
virtual



real



② Reconstruction



Real characteristics

①

① Typology of spatial structure (part 2)

② Point Processes (part 3)

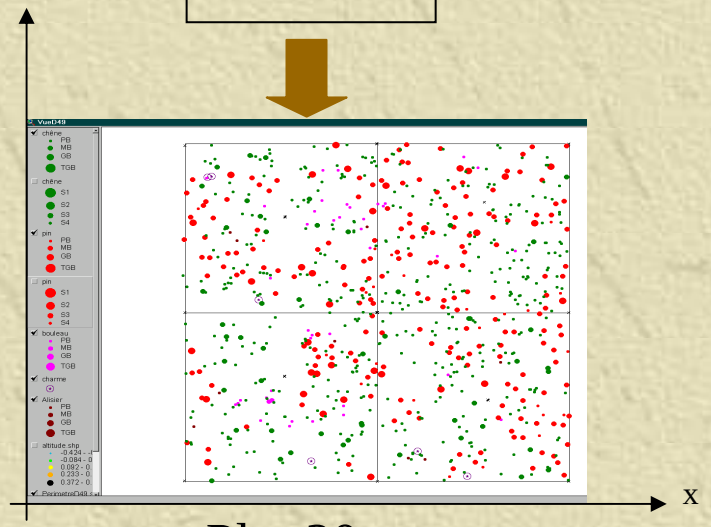
II. Characterising our oak-pine stands spatial structure

II. Characterising stands spatial structure

Horizontal distribution of trees in space

T_1 (x_1, y_1)
T_2 $(x_2\ y_2)$
.
.
.

T_n (X_n, Y_n)



Plot 20

The stand S, a set of trees T_n
Characterise by their locations (X_n, Y_n)

The stand is considered as a point pattern.

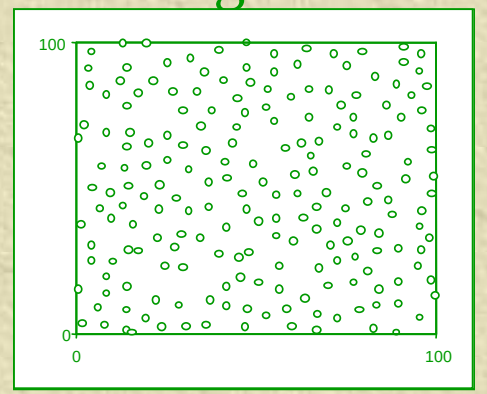
II. Characterising stands spatial structure

- The stand is considered as a spatial point pattern
- A spatial Point Process is a stochastic model that governs the location of points in an area (Cressie, 1993).
- An appropriate tool for examining spatial structure of trees in a forest stand

II. Characterising stands spatial structure

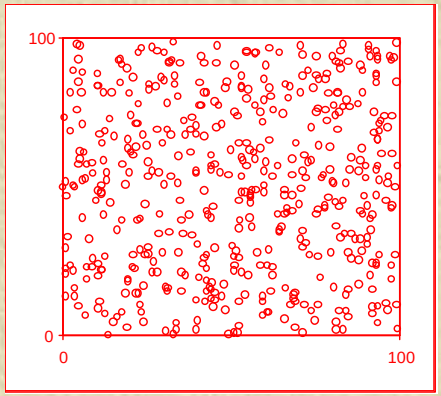
- Characterising the spatial point pattern by its second-order intensity, described by Ripley function (Ripley, 1977)
  - aggregation \random\ regularity
  - attraction \ independence\ repulsion

regular



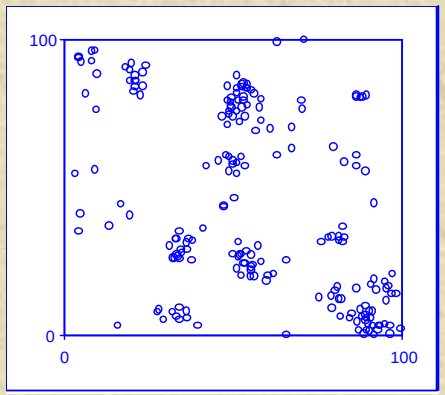
L(r) < 0

random



L(r) = 0

aggregated



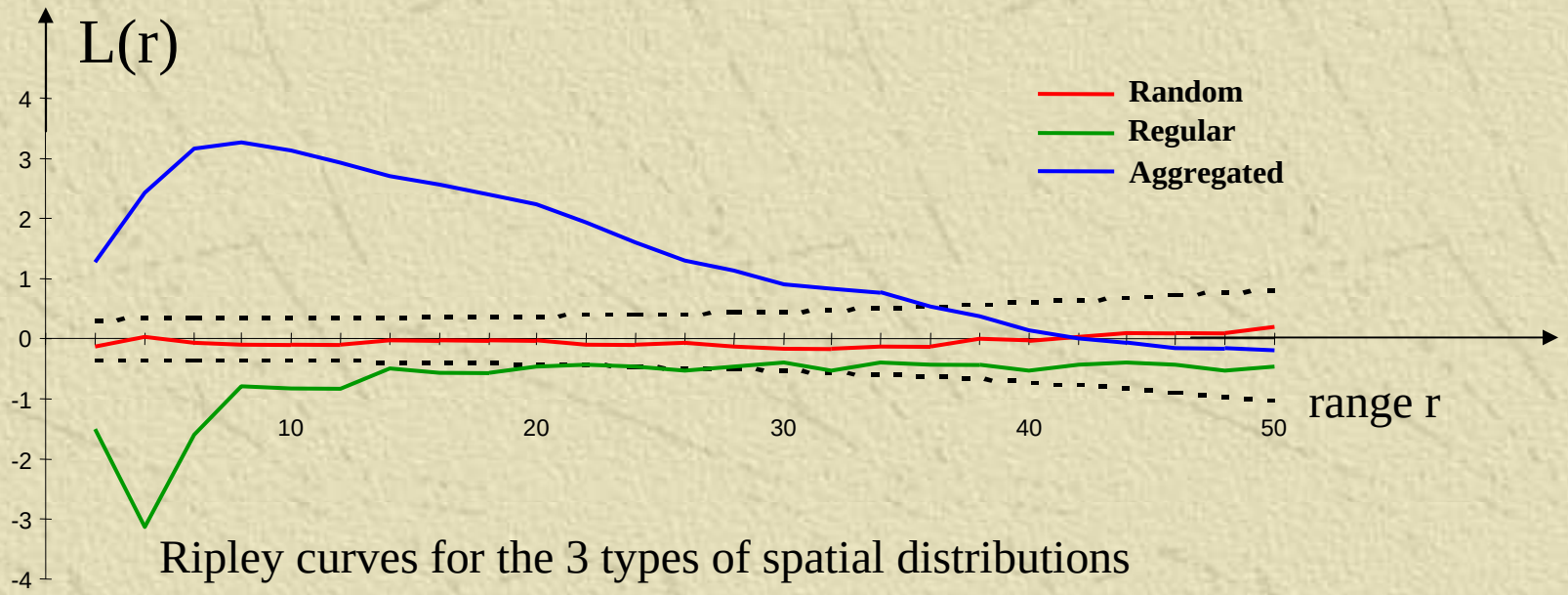
L(r) >0

$K(r) = \pi r^2$

II. Characterising stands spatial structure

- Characterising the spatial point pattern by L(r) (Besag in Ripley, 1977)

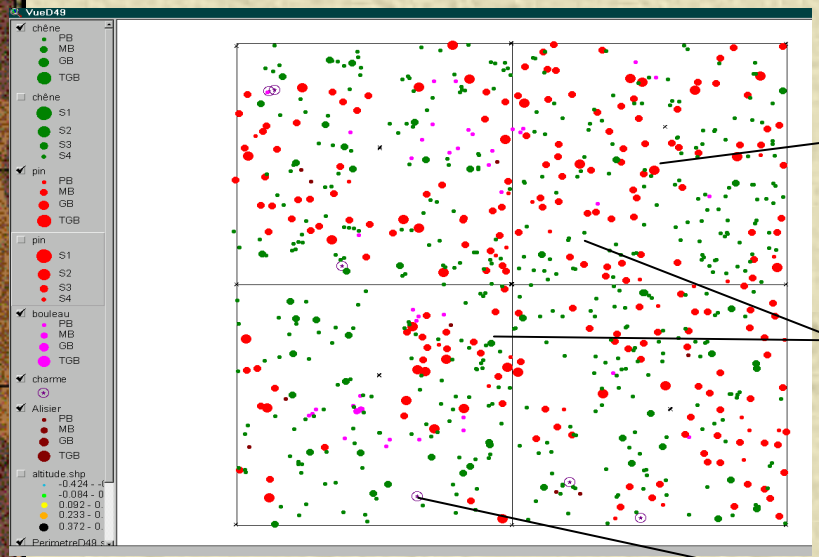
$$L(r) = (K(r)/\pi)^{1/2} - r$$



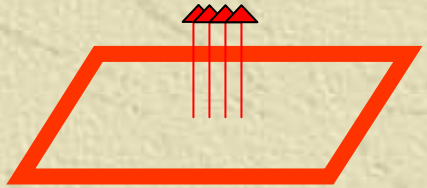
Ripley curves for the 3 types of spatial distributions

II. Characterising stands spatial structure

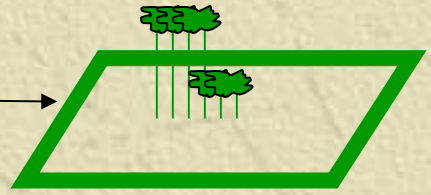
- 25 1ha mapped plots
- Defining sub-populations:



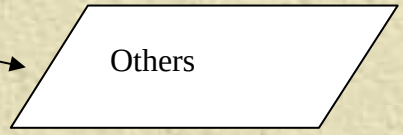
Plot 20



Canopy pines

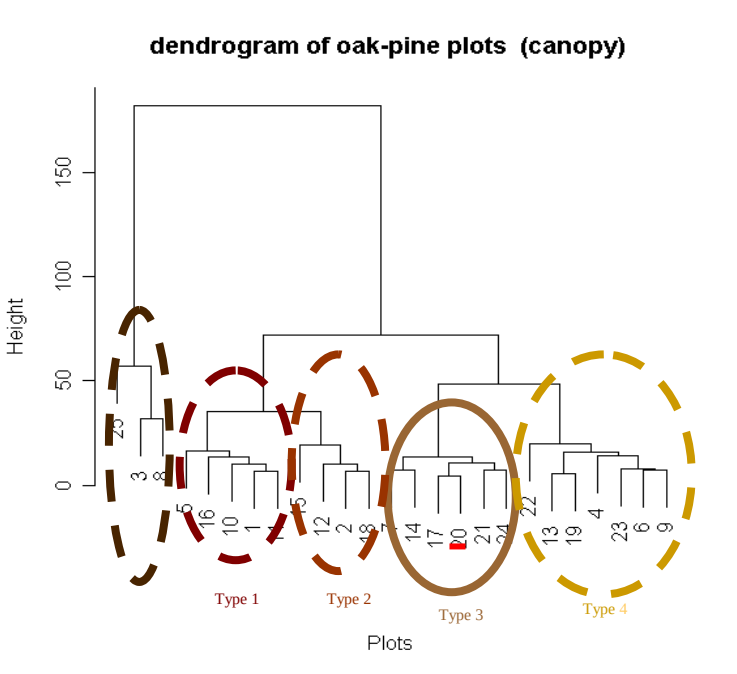


Canopy and Understorey oak



Modelling the spatial structure of complex stands

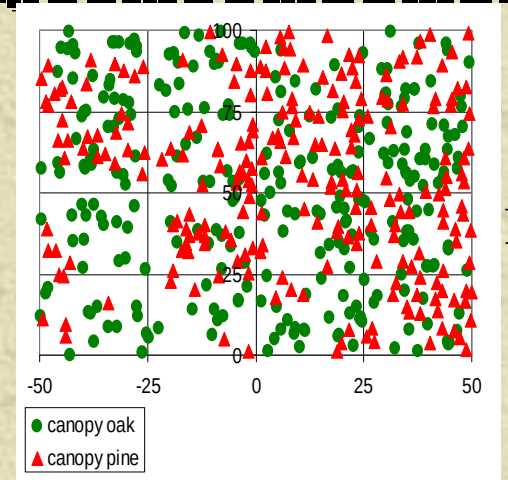
II. Characterising stands spatial structure



Typology of spatial structure

based on Ripley and Intertype

computed 25 1 ha plots

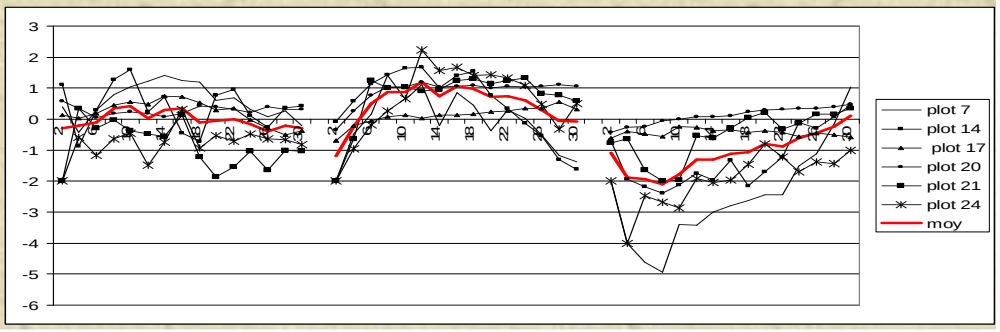


Plot 20

Type 3 :

- Random structure of oak
- Slight aggregation of pine
- Slight repulsion

$L_O(r)$ real $L_P(r)$ real L_{OP} real

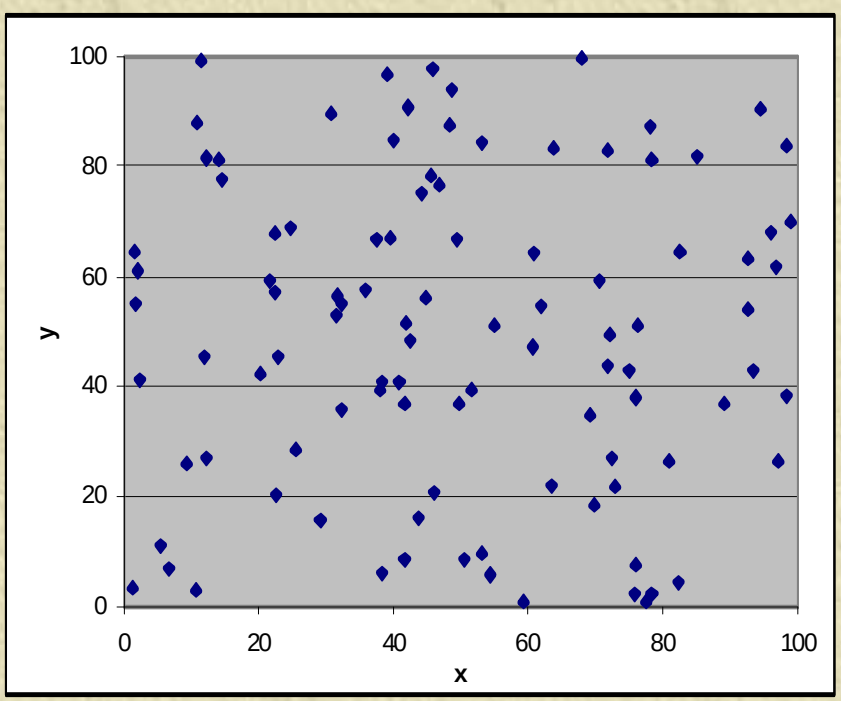


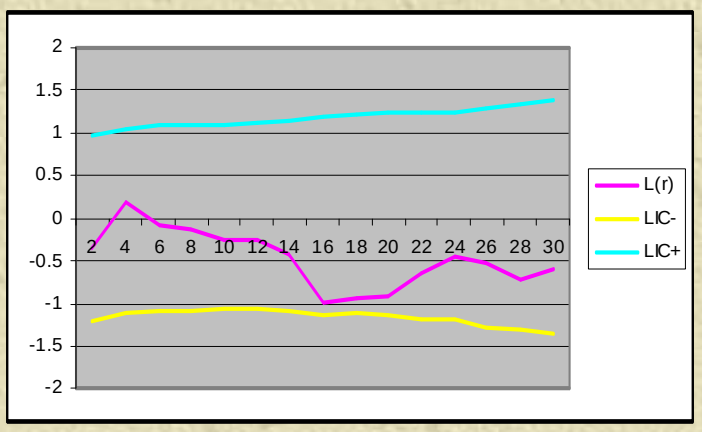
III. Reproducing the identified stand spatial structure

III. Reproducing stands spatial structure

The point processes used

- Poisson process: random pattern

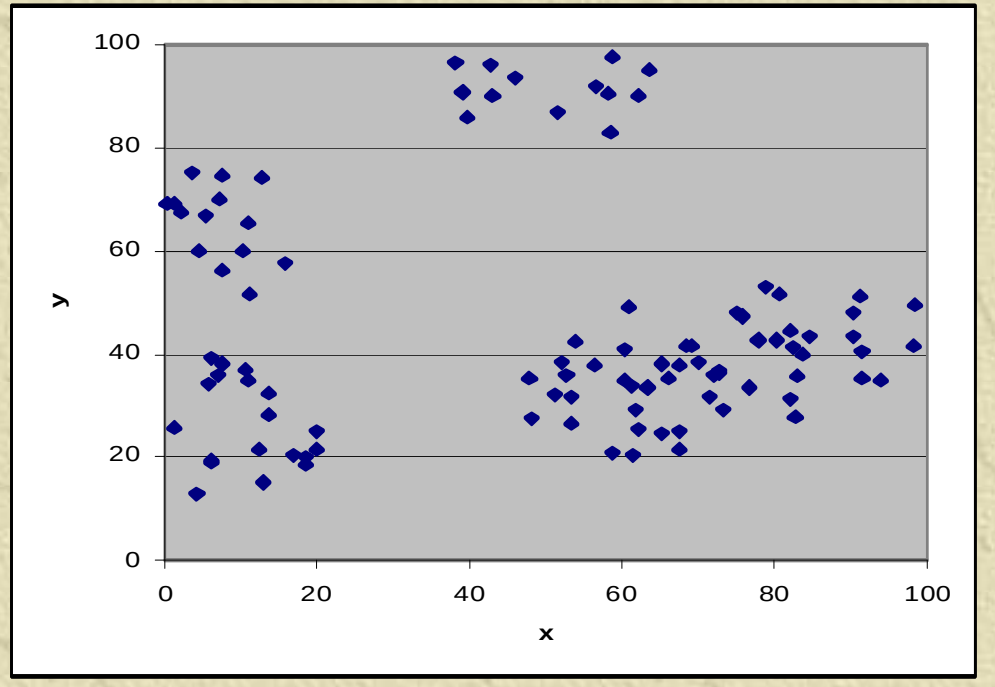


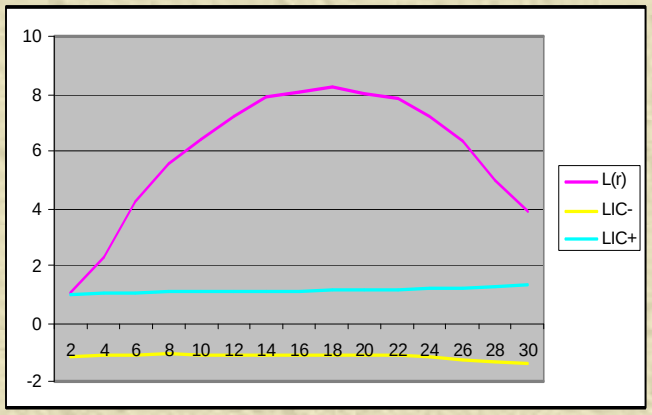


III. Reproducing stands spatial structure

The point processes used

- Neyman-scott process: aggregated pattern

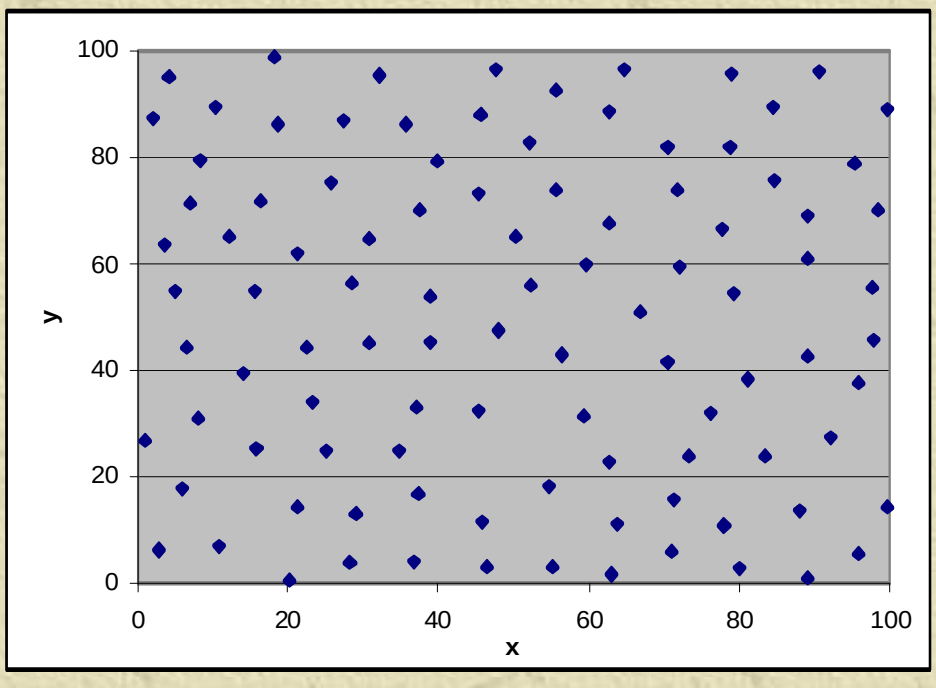


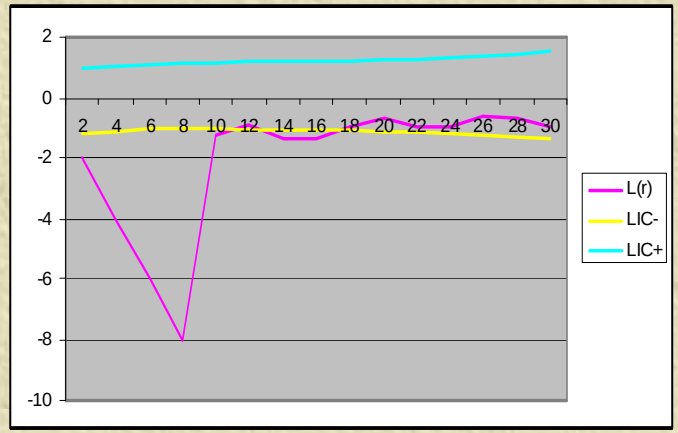


III. Reproducing stands spatial structure

The point processes used

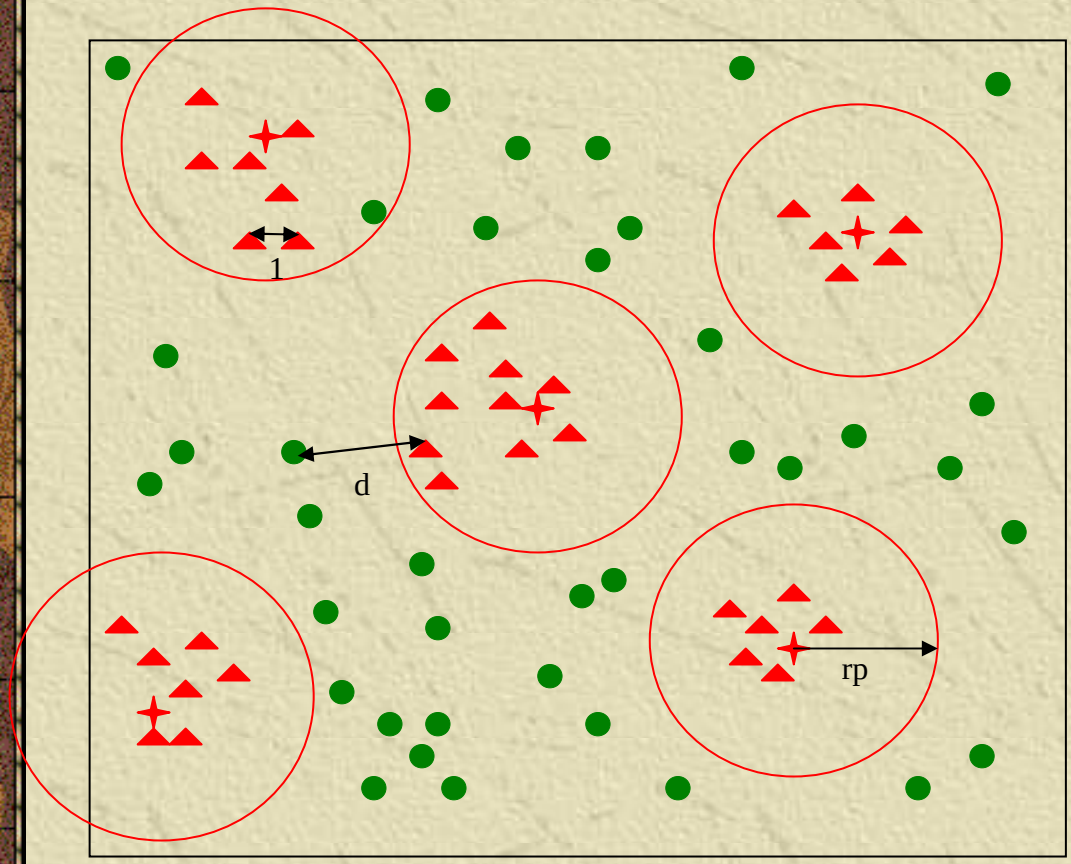
- Hard Core or simple inhibition process: regular or repulsive pattern





III. Reproducing stands spatial structure

Our model of structure



5 Parameters:

- N1 Pines

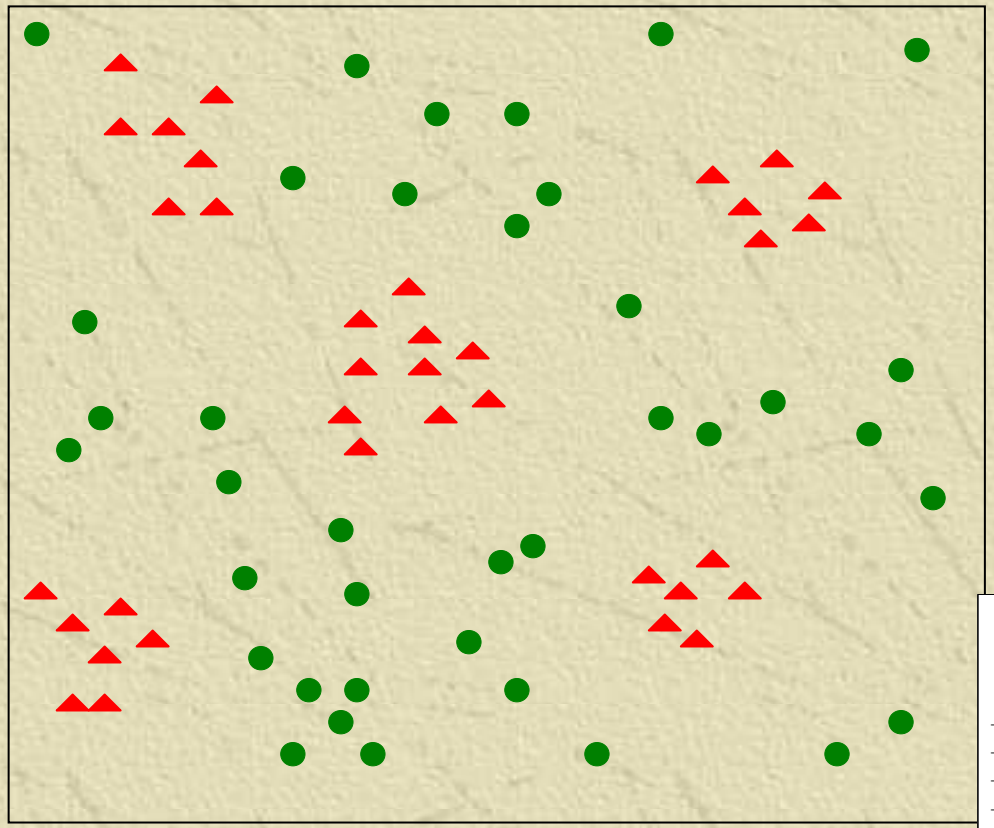
1) Nb of clusters
2) Rp: radius
3) l: regularity distance

N2 oaks

4) d: intertype distance
5) Pa (probability when d intertype is not respected)

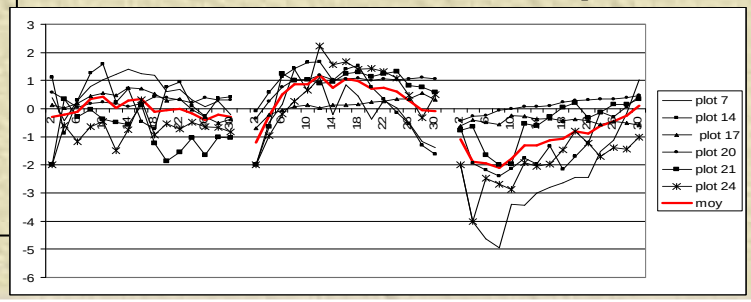
III. Reproducing stands spatial structure

Our model of structure



$L_o(r)$ simulated
$L_P(r)$ simulated
L_{op} simulated

$L_o(r)$ real $L_p(r)$ real L_{op} real



III. Reproducing stands spatial structure

- Our model of structure: fitting procedure by the least square criterion between the real and the simulated curves

$$SCE_1 = \sum_{r=2}^{30}(LO_m^{sim}(r) - LO_m^{th}(r))^2 + \sum_{r=2}^{30}(LP_m^{sim}(r) - LP_m^{th}(r))^2 + \sum_{r=2}^{30}(LOP_m^{sim}(r) - LOP_m^{th}(r))^2$$

Euclidean distance between the real and simulated mean curves

$$SCE_2 = \sum_{r=2}^{30}(LO_\sigma^{sim}(r) - LO_\sigma^{th}(r))^2 + \sum_{r=2}^{30}(LP_\sigma^{sim}(r) - LP_\sigma^{th}(r))^2 + \sum_{r=2}^{30}(LOP_\sigma^{sim}(r) - LOP_\sigma^{th}(r))^2$$

Euclidean distance between the real and the simulated standard deviations

$$SCE = SCE_1 + SCE_2$$

- What are the parameters that minimize the difference between Lreal and Lsim?

III. Reproducing stands spatial structure

Our model of structure: fitted parameters

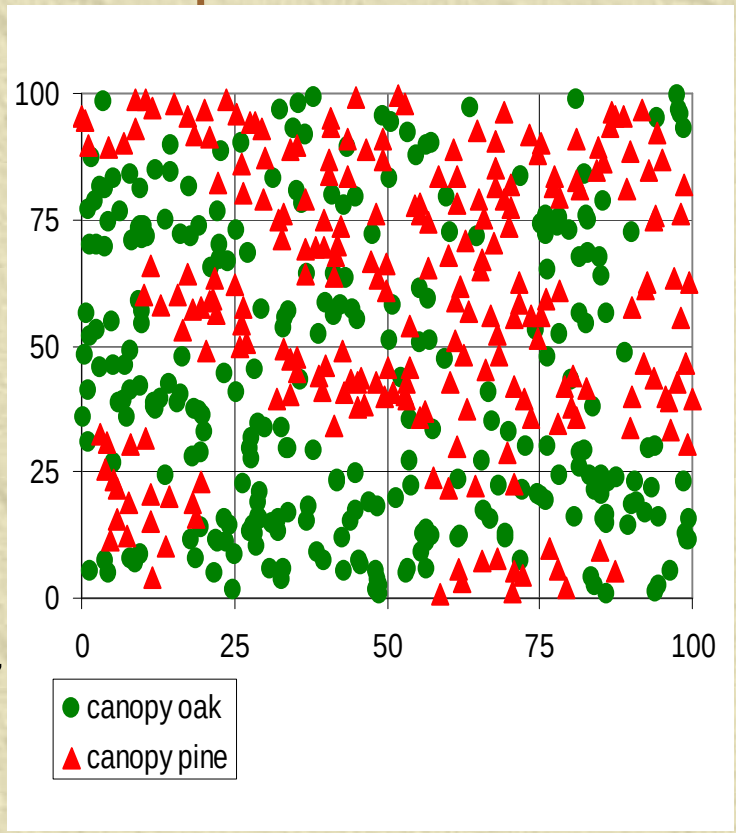
For Pines

- Nb of clusters: 38 /ha
- Radius: 8m
- Regularity distance: 10m

For Oak

- Intertype distance: 4m
- Pa: 0.15

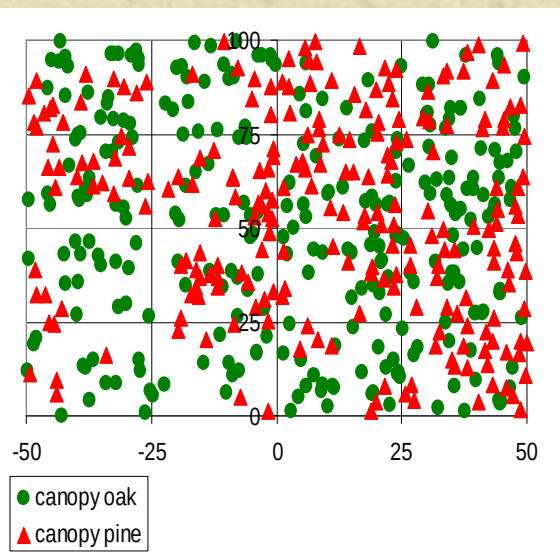
$$SCE_{min} = 17.77$$



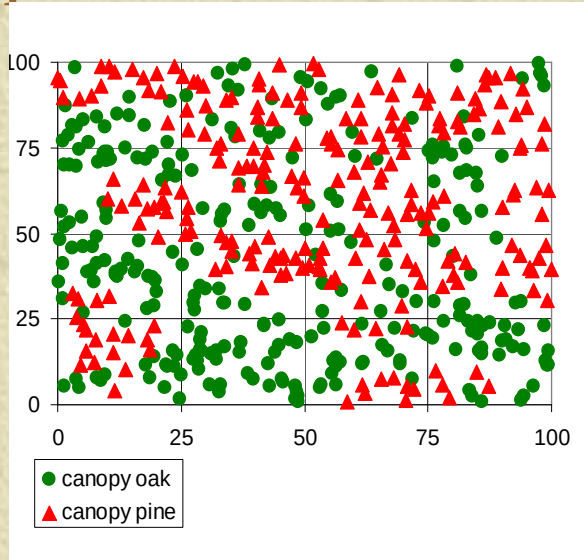
Simulated plot

III. Reproducing stands spatial structure

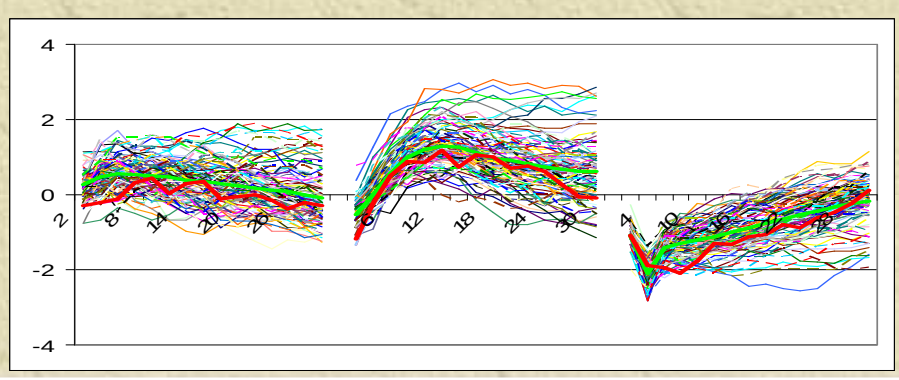
Our model of structure: comparison



Plot 20



Simulated plot



L real

L simulated

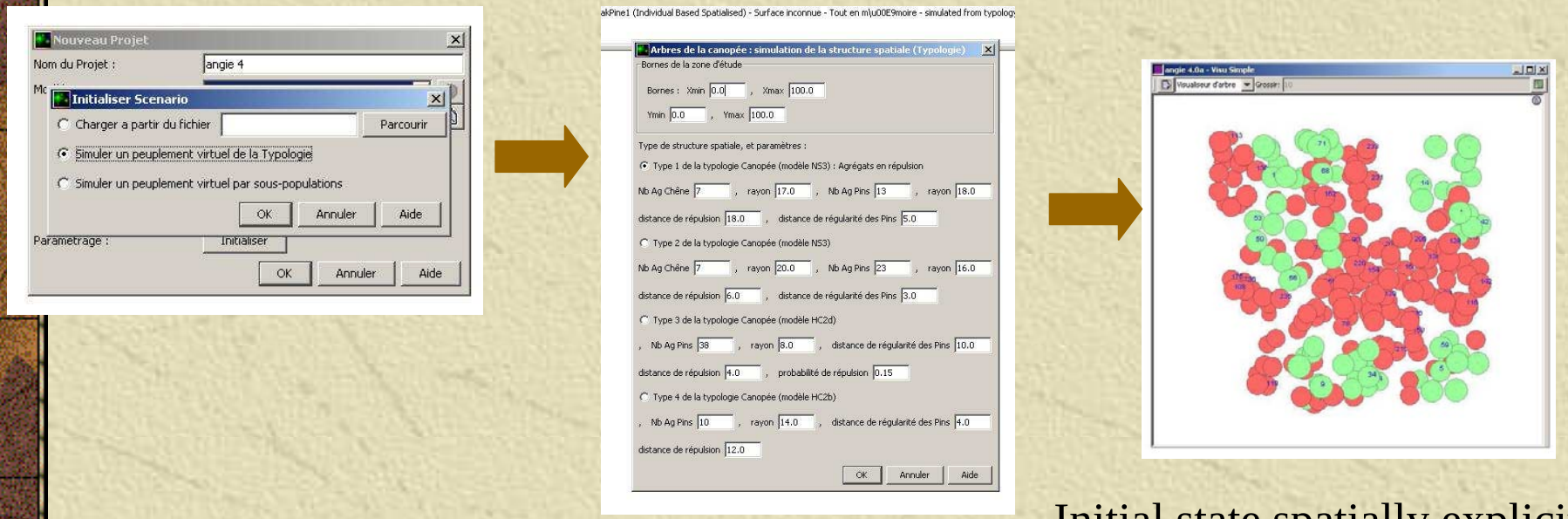
IV. Conclusions and perpectives

IV. Conclusions

- Models of spatial structure for oak-Scots pine mixed stands of the Orleans forest
- For all the identified spatial types of our typology
- Simple point processes to reproduce successfully the spatial pattern

IV. Conclusions

- On a simulator, CAPSIS, as initial state of a spatially explicit oak-pine growth model

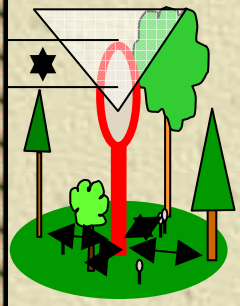


Initial state spatially explicit

IV. Perspectives

For any stand

Stand level characteristics

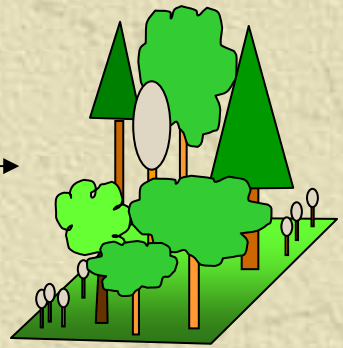


Experimental plots

Spatial structure analysis

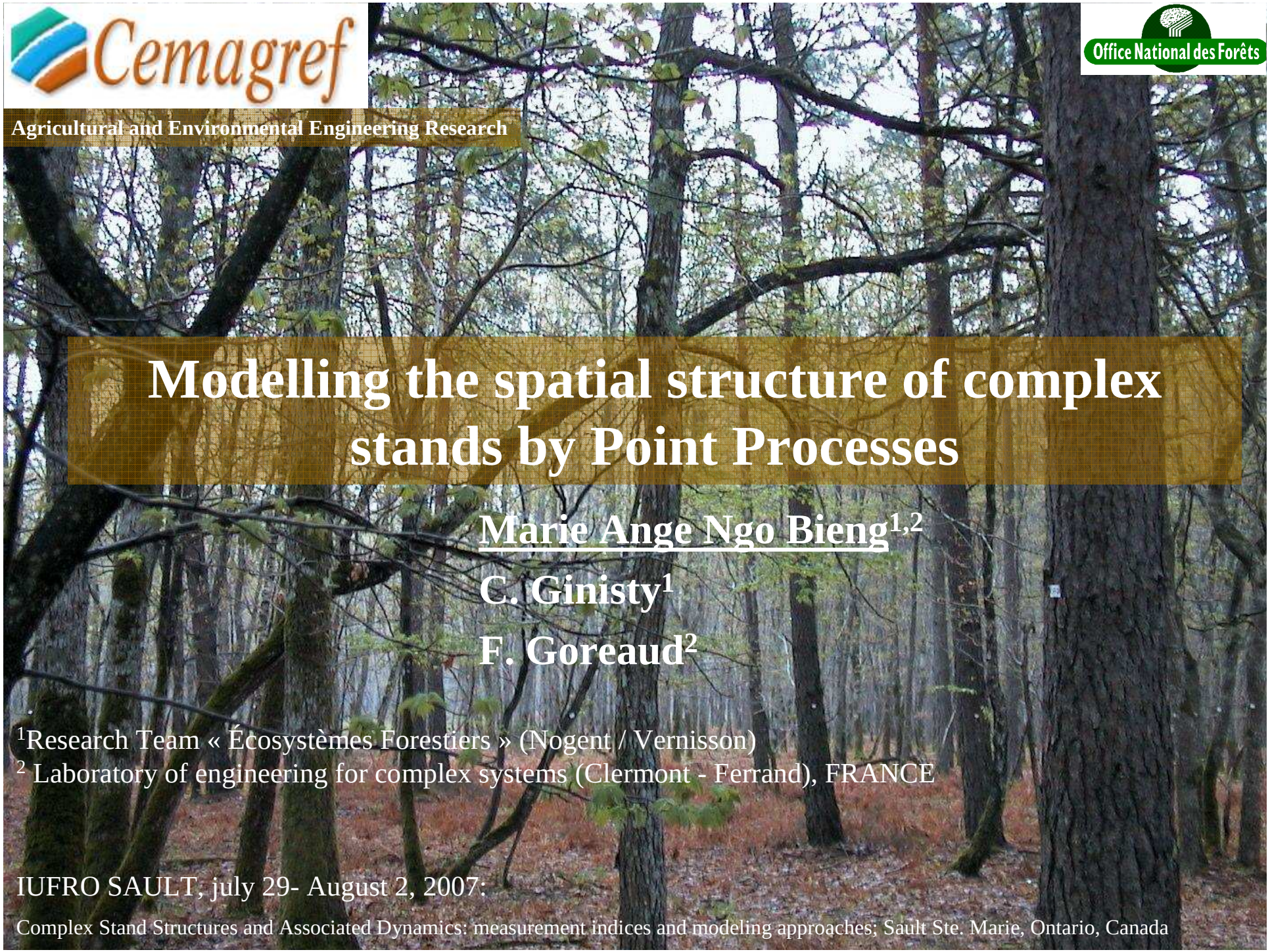
oak – pine
Spatial Typology

Point process



Virtual stand
Spatially explicit

IBM simulation



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